ASTEC has had a major study in progress on Foresight or *Matching Science and Technology to Future Needs*. This study has suggested scenarios in 2010 as imaginary—but possible futures in order to ask when developments might take place in science and technology and what issues might become most important.

The study is conducting a series of 'Partnerships' in a number of areas such as the information and communications industry, shipping, urban water supply and health. ASTEC is also seeking the views of youth. It is also conducting round-table discussions on key issues. One took place on 24 May in Sydney on the science system of the future.

ASTEC's scenario for 2010 challenged the discussion by proposing that by this time the use of Internet and communications technology had produced many changes in learning. Universities were internationally open and students could shop around for courses. It was suggested that research had also become more international and multi-disciplinary using Internet; CSIRO had become an international agency (a proposition that attracted some interest from the press); industry carried out more R&D but Government support for R&D had stayed about the same in real terms as now, making funding more competitive and linked more tightly to the Governments needs, such as the environment.

New technologies and discovery in medicine had responded to the search for prevention rather than cure. There are, of course, other futures.

The aim of these discussions is not to predict the future but to use optional futures to challenge the extent that the present system can adapt to trends that can already be detected, such as the role of information technology, the emergence of APEC and importance given to environmental values.

My aim today is to challenge thinking about science policy—both policy for science and science for policy by emphasising that policy—or strategy—needs to take the context of the future into account.

Mr Peter J. Laver fts

AN INDUSTRY EVALUATION OF AUSTRALIAN SCIENCE POLICY

The place of Science Policy

- Science Policy is *not* an end in itself.
- Science Policy is not research policy—it involves 'buying' new technology as well as 'making' or producing it domestically.
- Science is a component of virtually all government policies:
  - —industry;
  - —trade;
  - —agriculture;
  - —health/medical;
  - —defence;
  - —environment; and
  - —social.
- Need to determine where science fits in each.
- Answer is different in each case so a generic 'Science Policy' is not necessarily relevant.

Science Policy—what it is not/should not be

- A focus on inputs
  - —Dollars do not equate to quality or effectiveness.
  - —Business expenditure should be dictated by industry structure and business plans, not international comparisons (as useful as a policy on garden tools, street cleaning or sporting attendance).
- Balancing public and private outlays
  - —Private outlay on science is a business decision based on competing investment opportunities.
  - —Public expenditure is a political decision based on competing priorities and the inertia inherent in an existing establishment.
- Picking winners/setting priorities
  - —Criteria to be used by those not the users of outcomes are unclear.
  - —Business may be stupid or short-sighted but in the end it lives with the consequences.
  - —Government has role to consult and co-ordinate public interest science.
- Creating jobs—for scientists, tax specialists, lawyers, accountants, snake-oil salesmen
  - —Any policy measure intentionally or unintentionally having a primary impact of this nature should be abandoned.

Science Policy—what it should be

- Creating awareness/interest
  - —Community fear or apathy makes political support for science difficult.
  - —Attitudes significantly influenced by the school education system.
  - —Science lacks the inherent potential for popular acclaim/rewards of other fields of endeavour.
- Reducing risk/leveraging returns
  - —Investments of any type are rarely simply 'go'/

'no go' decisions but fall within a spectrum, influenced by both quantitative and empirical factors.
- —Science and technology decisions need to compete with other investment opportunities.
- —Anything government can do to reduce risk or enhance reward will lift science outlays.

• Providing trained, motivated people
- —A component of both awareness raising (attracting more of the right people into science) and of risk reduction (reducing the cost of investment in science).
- —Ideally a flexible education system is required, creating lifelong learners responsive to changing demands, more likely to be a product of a government than an industry driven system.
- —Links between teaching and research in higher education are invaluable, if not essential.

• Funding the pursuit of knowledge
- —Every country needs to devote some resources to expanding human knowledge; richer countries more so than poor countries.
- —The amount devoted should be a policy matter, similar to decisions on education, welfare etc.
- —Indicators as to quantum can be provided by international comparisons and assessing what the marginal outlay would be.
- —Research training is an essential component of pure research activities.

• Addressing market failure
- —Government science policy needs to cater for areas where co-operative research efforts can be beneficial but the individual beneficiaries are too small to initiate and manage the work —agriculture is the prime example.
- —Public good research where there is no identifiable customer or beneficiary also requires support—climate, environment, most medical research.
- —Less clear cut is the need to intervene to support visionary, high quality work in the stage before it can attract venture capital.

Evaluation of current Science Policy features

• Government research laboratories CSIRO/ANSTO etc.
- —World class research is done but effectiveness could be improved.
- —Meet most of the criteria for basic and public good research but applied research could be managed more flexibly.
- —Improvement with more industry direction at Institute level, Institute specific goals, procedures and policies directed to outcomes and leveraging external contributions.

• Tax concessions/IR&D grants
- —These have been seen to be good schemes and highly effective in increasing Business expenditure on research.
- —Disappointingly low number of eligible companies are utilising the schemes.
- —Of concern is whether for the outlay involved the government is receiving the optimum return on its investment, as some research is being driven by the wrong motives and may not be well managed.

• CRCs and AECs
- —Have been demonstrated generally to be highly effective in expanding well managed applied research and leveraging government outlays.
- —Competitive basis instrumental in setting national research priorities.
- —The system needs to be granted permanent status but also needs mechanisms to reduce centres, re-allocate funds and start new ventures.

• ARC/NH&MRC
- —Well respected and managed schemes producing effective basic research.
- —Success rate is too low so either funds need to be increased or application criteria tightened.
- —Excellence should remain prime criterion but relevance needs to be considered, particularly if there is an associated CRC to benefit from the resulting research training, skills and new basic science.

• Rural research corporations
- —Generally meet all criteria and provide effective science underpinning for diverse sectors.
- —Emphasis needs to be on market pull, matching industry contributions, technology transfer avenues and balancing longer term strategic needs with shorter term tactical problem solving.

• Science and technology awareness programmes
- —A major need exists to increase the pool of talent in science and engineering, to heighten community awareness and support for science and to ensure science and technology is better understood in business (especially financial markets) and government.
- —Efforts need to be broadly based but particularly focussed in schools, some existing outlays need to be evaluated e.g. Australia Prize.

• International links
- —Policy needs to be handled with caution to ensure it supports rather than replaces or distorts market based initiatives.

—The role should be to act as an identifier of opportunities and broker, not a long term participant.

Conclusion

- Australian Science Policy in general is sound and meets most of the desirable attributes.
- Government outlays on science are substantial and must be continuously monitored to ensure that they are yielding the optimum return for taxpayers.
- Science policy will only be effective when considered as a component of other government policies, as a means to achieving various social and economic objectives. It is not an end in itself.

PROFESSOR SIR GUSTAV NOSSAL AC FRS FAA

AUSTRALIA'S SCIENCE POLICY

The nature of science

Ever since human beings started to cultivate crops in the fertile crescent some 8 millennia ago, and probably long before that, humans have expressed their desire to understand and, if possible, conquer nature. The yearning for greater understanding seems to be buried deeply within human consciousness. The most accurate birthday to assign to the birth of science is the birthday of *Homo sapiens*, which seems to keep fluctuating but at a best guess is about a million years ago. I hold unshakeably to the belief that science is primarily about ideas, is integrally involved with the quest for greater knowledge of the world around us and of ourselves. This being said, it seems undoubted that there was a major acceleration in the activity that we call scientific research stemming from about the time that Galileo died and Newton was born, i.e. the last 300 plus years. Few would deny the proposition that steep acceleration in scientific activity was occasioned by the industrial revolution and two world wars.

Faustian bargains in science

Thus we see that from the dawn of the scientific age there are issues to be faced at the interface of science and technology. Knowledge is desirable and good, but scientific knowledge is somehow categorically different from other sorts of knowledge in that it is vectorial, incrementally verifiable and ineffably powerful. Scientific insights that brook no contradiction lead to powers that know no limits. It is actually interesting to reflect on the number of occasions that scientists have misread the implications of their own work. Rutherford thought that atomic physics was an interesting intellectual exercise. Marconi thought that wireless would be useful for ship to shore communication. The scientists from Rhone-Poulenc who invented the world's first major drug for the treatment of psychoses thought they were inventing an anti-shivering agent for cardiac surgery. Many scientists who love the world of ideas, who struggle to reach insights before their competitors, have no particular concern for where the discovery might eventually lead humanity.

Science Policy thus a house of cards

This being the case, science policy has to be built on shifting sands. There is a tremendous temptation to force the scientific enterprise into a modality that is technological rather than scientific. There will be a time in the development of any science that the technological and practical spin-offs become obvious. There will also be joyous, intellectually challenging, fascinating and fantastic things requiring to be done within the domain of technology for society to get the maximum dividend from scientific discoveries. Nor is it a simple linear sequence. Frequently, the problems and challenges that emerge as scientists struggle to make breakthroughs from the world of ideas practically useful in the world of human beings and their daily concerns will feed back to the basic scientists undreamt of challenges. An enlightened science policy will take due heed of these imperatives.

Australia's position in science and technology

For reasons that are not easy to discern, the great effort that went into Australian science and technology between the years 1930 and 1980 was somewhat slanted towards the fundamental end of the science and technology spectrum. Starting with CSIRO, moving onto the Australian National University, and finishing with the enormous upsurge of the Australian universities after the Murray Report and Martin's assumption as head of the Australian Universities Commission, we have a situation in Australian research where the basic science end is fantastic, where a certain applied research capacity exists, but where there is a significant lack of recipient vehicles within